Topics in Geriatric Rehabilitation • Volume 33, Number 2, 98-103 • Copyright © 2017 Wolters Kluwer Health, Inc. All rights reserved.
DOI: 10.1097/TGR.0000000000000103

Patient Characteristics and Functional Outcomes in a 5-Year Retrospective Stroke Cohort

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Objective: This retrospective study examined the relationship between patient characteristics and intervention outcomes in stroke rehabilitation in a large, diverse inpatient database.

Method: A query of the electronic medical record for 2008-2012 identified 939 patients treated for stroke. An analysis was conducted for dichotomized total, motor, and cognitive Functional Independence Measure scores using univariable and multivariable analyses and patients' characteristics.

Results: There was a significant population of non-white patients in the cohort (53%). Race was not found to be a factor that influenced outcomes. Patients who responded to treatment were more likely to be younger than 80, with a length of stay greater than 11 days, and currently employed. Length of stay had the strongest association with a positive treatment response ($P \leq 0.001$). Patients who were older than 80 years and not working/retired at the time of stroke had less response to treatment.

Conclusion: The results of the present study show that patients with a minimum of 3 key characteristics, in a diverse stroke population, are most likely to benefit maximally from intensive inpatient stroke rehabilitation irrespective of their race, sex, or number of comorbidities.

Key words: Functional Independence Measure, inpatient stroke rehabilitation, patient characteristics, stroke outcomes

In the United States, approximately 795000 people experience a stroke each year.[1] The American Heart Association predicts that by 2030 there will be an increase of 25% in the prevalence of stroke, primarily because of a large aging and diverse population.[2] Because of early medical intervention and advances in medical care and rehabilitation, individuals are increasingly surviving a stroke.[3] The cost of stroke-related care has been estimated at approximately $36.5 billion per year in 2014 and is expected to double in the next 20 years.[4] Inpatient rehabilitation is the first line of stroke care where patients undergo intensive rehabilitation in the hospital. A large body of research suggests that the opportunity window for maximum improvement in functional status following a stroke is the first few weeks.[5] Therefore, it is important to continuously examine and re-examine the process of inpatient rehabilitation and practices to identify patient characteristics that respond well to intensive rehabilitation for faster recovery.

Large database studies are warranted to continue to isolate demographic and other factors or combination of factors that are influential and predictive of a positive outcome. A number of patient characteristics have also been identified that may impact their response to rehabilitation (ie, age, education, physical status).[6] Studies have examined race as a factor influencing outcomes, but primarily the differences between white and black populations.[7] The cohort for this study, in internal hospital reports from 2012, indicates that the hospital has a much higher number of Hispanic patients when compared to the region or nation—17.2% compared with 3.8% or 5.7%, respectively (e-mail communication, June 2015). A large database study is definitely warranted in a stroke population that is diverse in race, sex, education, etc. South Florida population offers an exciting opportunity to address the issue with respect to a Hispanic population. Using electronically available retrospective data, the goal for this study was to examine the relationship between patient characteristics and outcomes, as measured by the Functional Independence Measure (FIM), a standardized outcome measure used in many inpatient rehabilitation facilities.

METHODS

Following institutional review board approvals and a data sharing agreement with the hospital, 5 years of electronic medical chart data from 2008 through 2012 were examined. Memorial Regional Rehabilitation Institute is a large, urban, inpatient hospital in South Florida. Researchers collaborated with the rehabilitation staff to establish inclusion criteria based on the study purposes.

The hospital's information manager for the rehabilitation department ran a query based on the inclusion criteria of (*a*) diagnosis of stroke, (*b*) initial admission for inpatient rehabilitation for this impairment between 2008 and 2012, and (*c*) discharged to home. We targeted a specific group of patients who we theorized would have shown a response to treatment—patients who were discharged home. Home is the most common discharge destination from this inpatient rehabilitation setting. This database query yielded a population of 1002 patients, who met the inclusion criteria, formatted into an excel file.

Data collection

Following the identification of the larger population of patients treated for a stroke, a query was run to capture more detailed patient information. Additional data on each patient were gathered from the Medicare summary form known as the Patient Assessment Instrument from the Department of Health and Human Services Centers for Medicare and Medicaid Services. The Patient Assessment Instrument included detailed demographic information, admission and discharge information, and medical information (including up to 10 comorbid conditions). The FIM scores on admission and discharge in the assessed areas of self-care, sphincter control, transfers, locomotion, communication, and social cognition were extracted from the electronic medical record (EMR). The FIM scores are on a scale of 1 to 7 with 1 indicating the need for total assistance and a score of 7 indicating complete independence. Each entry was identified by a medical record number and no names or addresses were recorded as a part of the database. The data were stored on a password protected external flash drive and was stored in a locked and secure office.

Data analysis

The database initially included 1002 patient records. On further review of the data, it was determined that 63 records did not meet one of the inclusion criteria (initial admission) and were excluded; leaving N = 939. The data set was in an excel format and converted into a Stata format.[8] Initial analysis used descriptive statistics to look at general patient characteristics considered to be potential predictors of patients' treatment response. Characteristics considered included demographic characteristics such as age, sex and race, employment status, length of treatment duration, and number of comorbidities as potential predictors of treatment response. A change of the total FIM score was calculated by subtracting the admission score from the discharge score. A minimal clinically important difference (MCID) was calculated on the basis of prior research on the FIM.[9] Patients were then separated into groups on the basis of their change of scores. If the change of FIM from admission to discharge was above the MCID, then the patients were categorized as responding to treatment or below the MCID as not responding to treatment (see Table 1). A FIM MCID is considered to be as follows: Total: 22, Motor: 17, and Cognitive 3. Scores for total FIM and for each of its subscales, motor and cognitive FIM, were calculated as well as the difference between baseline and end of treatment values for each of the FIM scores with respective 95% confidence intervals (CIs). Positive differences between baseline and end of treatment indicate less disability after treatment. A response analysis was conducted for dichotomized total, motor, and cognitive FIM scores using univariable and multivariable analyses to identify patients' characteristics potentially associated with treatment response. Generalized linear models were used to derive risk ratios of treatment response with 95% CIs, using a Gaussian distribution with robust variance estimation to address problems with model convergence.[10] Risk ratios of treatment response above 1 indicate a lower response to treatment in the reference category of patients' characteristics. All *P* values are 2-sided. All analysis was done using Stata 13.[8]

RESULTS

Table 1 presents demographic information of our study population. Patient characteristics listed show the overall makeup of the group and, in the other 2 columns, they are presented according to treatment response. The stroke population largely consisted of older adults (mean age 65.4 years), a similar number of men and women (49% and 51%, respectively), with an average length of stay (LOS) of 15.6 days. Approximately half of the patients were white (47%), a third African American (34%), and the remaining 19% Asians and other racial groups (primarily Hispanic). This racial diversity is similar to the projections for the US population by 2050.[11] Patients had an average of 8.4 listed comorbid conditions.

The mean values and 95% CIs for the total and subscale scores for the FIM, at baseline, end of treatment, and respective differences were also calculated. All scores improved after treatment, and CIs indicate that there is sufficient statistical evidence to support improvement in disability, that is, the probability that the improvement in disability was not null after treatment was at least 95%. Most of the patients had a clinically relevant improvement of their overall disability after treatment (83%). More patients had a clinically relevant improvement in motor function (88%) than in cognitive function (69%). When the total FIM results were analyzed by subgroups of motor and cognitive components, the motor FIM showed the greatest amount of improvement (see Table 2).

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The authors acknowledge the partnership between Florida International University and Memorial Regional Health South that made this research possible.

There are no disclosures of support.

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TABLE 1 Characteristics of Data Set

Characteristics	Overall Response to Treatment		
	N = 939	No (n = 159)	Yes (n = 780)
Age	65.4 ± 14.8	69.6 ± 14.3	64.5 ± 14.8
Length of stay	15.6 ± 8.9	11.8 ± 8.0	16.4 ± 8.8
Comorbidities	8.9 ± 1.6	8.7 ± 1.9	9.0 ± 1.6
FIM at admission	61.8 ± 18.2	72.3 ± 18.1	59.7 ± 17.5
Sex: Male	457 (48.7%)	64 (40.3%)	393 (50.4%)
Race			
White	438 (46.6%)	79 (49.7%)	359 (46.0%)
Black	317 (33.8%)	47 (29.6%)	270 (34.6%)
Asian	23 (2.4%)	3 (1.9%)	20 (2.6%)
Other	161 (17.1%)	30 (18.9%)	131 (16.8%)
Marital status			
Married	446 (47.8%)	74 (47.4%)	372 (47.9%)
Single	172 (18.4%)	24 (15.4%)	148 (19.0%)
Widowed	168 (18.0%)	38 (24.4%)	130 (16.7%)
Divorced	147 (15.8%)	20 (12.8%)	127 (16.3%)
Working	300 (31.9%)	31 (19.5%)	269 (34.5%)

Abbreviation: FIM, Functional Independence Measure.

Figure 1 shows risk ratios of potential predictors of treatment response from univariable and multivariable analyses. The univariable analysis indicated that patients who responded to treatment were more likely to be younger, male, with longer LOS, and currently employed ($P \leq 0.020$). Results were much the same in the multivariable analysis, where treatment effect estimates were adjusted for potential confounding. Again, patients who responded to treatment were more likely to be younger, with longer LOS, and currently employed ($P \leq 0.025$), but sex was no longer predictive of treatment response ($P \leq 0.13$). LOS had the strongest association with treatment response, and patients with over 10 days of LOS were at least 24% more likely to respond to treatment when compared to patients with 10 days or less (11-20 days of LOS risk ratio = 1.24, 95% CI = 1.15-1.34; >20 days' risk ratio = 1.26, 95% CI = 1.16-1.36). Patients did not show any difference in their response to treatment based on racial categories.

Analysis of the risk ratios of potential predictors of treatment response from univariable and multivariable analyses for motor and cognitive function FIM subscales showed similar results to the total FIM analysis. Patients who had a clinically relevant improvement in motor function were more likely to be younger, with longer LOS, and currently employed ($P \leq 0.035$), while the only predictor of a relevant clinical improvement in cognitive function was LOS ($P \leq 0.001$). LOS was a stronger predictor of clinically relevant improvement for cognitive function (11-20 days' risk ratio = 1.30, 95% CI = 1.15-1.47; >20 days' risk ratio = 1.54, 95% CI = 1.37-1.73) than for motor function (11-20 days' risk ratio = 1.13, 95% CI = 1.06-1.19; >20 days' risk ratio = 1.12, 95% CI = 1.05-1.19).

TABLE 2 Response to Treatment as Measured by the FIM

Outcome	Baseline, Mean (SD)	Follow-up, Mean (SD)	Difference From Baseline, Mean (95% CI)	Response, n (%)
FIM 1	53.0 ± 15.6	82.5 ± 13.9	29.5 (28.8-30.1)	750 (79.9)
FIM 1m	30.8 ± 10.6	55.0 ± 10.1	24.3 (23.8-24.8)	803 (85.5)
FIM 1c	22.3 ± 7.8	27.5 ± 6.2	5.2 (4.9-5.5)	645 (68.7)

Abbreviations: FIM, Functional Independence Measure; FIM 1, total FIM score; FIM 1m, motor FIM score; FIM 1c, FIM cognitive score.

Risk Ratio Analysis of Factors and their Influence on Response to Treatment

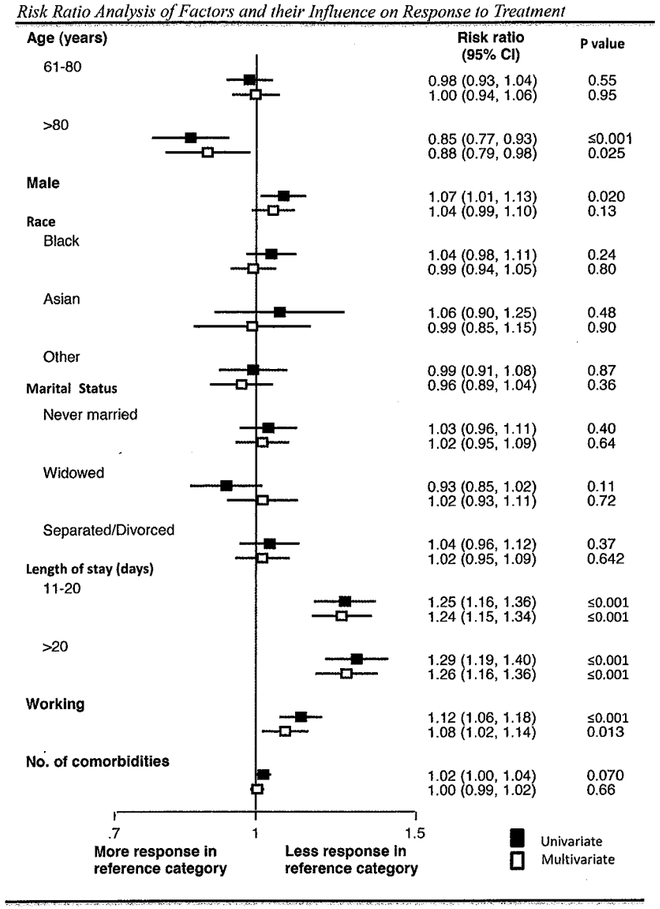

Figure 1. Risk ratio analysis of factors and their influence on response to treatment. Reference categories: age (<61 years); race (white); marital status (married); length of stay (<11 days); working (not working). CI indicates confidence interval.

DISCUSSION

Inpatient rehabilitation is the most important rehabilitation intervention in promoting recovery for patients with a stroke. The inpatient model of treatment offers an intensity of services in relatively brief periods of time. The LOS of this patient group corresponded with other research,[12-14] suggesting that LOS has the strongest relationship to response to treatment. The analysis of the present study indicates that patients who had a LOS of 11 to 20 days were more responsive to treatment as measured by a change in FIM score than those patients staying less than 11 days. However, a longer than 20-day LOS did not show any additionally significant improvement in the patient's positive response to treatment. Although not analyzed in this study, other research suggests that increased LOS for stroke is often associated with number of comorbidities or how sick the patient was during admission.[15]

There were two other factors that correlated to response or no response to treatment. Patients who were

working prior to the stroke and patients who were younger than 80 years had a significantly positive response to treatment. This supports findings in other stroke cohort studies.[16] Other factors such as number of comorbidities, sex, and marital status did not relate to the patient's ability to respond to treatment. Racial comparisons have frequently been between black and white populations and it is significant to note that there were a large number of Hispanic patients represented and that race was not a factor in a person's ability to respond to treatment. Age, LOS, and working explained approximately 65% of the variance in this sample population. Research suggests that functional status at admission, rather than other factors, is a better predictor of functional outcomes[17] and age, when patients are older than 80 years, explained only 16% of the variance compared with a 3.6% variance in a similar study with patients over 75 years of age.[18] Our findings also support recent research that older patients (>80) have less response to treatment in comparison to younger cohorts.[16] The characteristic of work may relate to a more functional status prior to the stroke and a potential to respond to treatment. The findings suggest old age is a negative factor however; overall, there is support for inpatient rehabilitation as an effective intervention for elderly patients.[16]

This patient cohort at Memorial Hospital Rehabilitation Institute with a stroke represents a current diversity that will be the future of America. Screening and identifying patients who can benefit from inpatient stroke rehabilitation is important in the clinical decision-making process. These findings suggest that a group that was slightly older (69.6) than the average (65.4) and had higher FIM scores at admission (72.2 compared to the average of 61.8) was not responsive to treatment. This group of patients who came in at a higher functioning status need to be examined further for characteristics or rehabilitation needs that may have been unmet. Patient characteristics and factors such as functional status prior to stroke, age, and severity of stroke are predictors of patient's ability to respond to an intensive inpatient rehabilitation program.[19] In addition, patients in a rehabilitation setting with LOS over 11 days offered improved opportunity for more functional gains.

The process of inpatient stroke rehabilitation continues to be poorly understood. Research has widely recognized that patients who receive inpatient rehabilitation improve; that generally scores from admission to discharge show progress. It is less understood how the treatments and processes and patient characteristics *during* rehabilitation influence those outcomes. Patient characteristics and how they may interact with the rehabilitation process can help rehabilitation professionals tailor more individualized or precise treatment methods. There is no standardization of documentation that details activities and interventions to describe the process of rehabilitation. It has been suggested that to untangle the process, a method of documentation that identifies patient characteristics and classifies activities and allows for a broad collection of data and for comprehensive analysis could help unlock the "black box" of stroke rehabilitation.[6,20]

Limitations

The study data were collected from 1 regional medical rehabilitation center. The population was diverse with approximately half of the group identified as minority or other than white participants; however, future studies should include multiple sites that represent differing geographic and/or economic locations. A broader inclusion criterion to include all patients with a stroke regardless of discharge placement could further help to differentiate between groups of patients and factors that are linked to better outcomes. As a retrospective study, we were not able to collect a severity index for the sample. Controlling for severity would, in a prospective study, strengthen the findings. We were also reliant on what we could record from the EMR. The increasing use of the EMR may be an opportunity to standardize documentation in a more inclusive way.

IMPLICATIONS

A prospective study has the potential to create a documentation process that collects a robust amount of data in real time that can be analyzed and create connections between patient characteristics, treatment processes, and outcome. Adding data about rehabilitation interventions such as occupational therapy, physical therapy, and speech and language pathology can help explain more comprehensively the rehabilitation process and the impact on outcomes for people with stroke. The increasing use of the EMR may be an opportunity to standardize documentation in a more inclusive way. A standardized documentation process can provide rich data on assessment, intervention, therapy process, and outcomes that can be subjected to statistical analyses. Pairing this information with patient characteristics has the potential to create protocols that can personalize interventions to meet the needs of the individual patient. In addition, these approaches to documentation and data collection can help rehabilitation specialist working with individuals with stroke generate evidence for their practice and advocate their services to the people they serve.

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